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REVIEWS.

The great Ice-dams of Lakes Maumee, Whittlesey and Warren. By FRANK BURSLEY TAYLOR, Fort Wayne, Ind. American Geologist, July 1899, Vol. XXIV, pp. 6–38, Pl. II and III.

Two years ago Mr. Taylor contributed to Pleistocene geology a new working hypothesis.[1] Pointing out that the recessional moraines left by certain lobes of the Laurentide ice sheet on plains or in broad smooth valleys were characterized by regularity of interval, he postulated that this regularity was caused by a definitive rhythm in the general conditions controlling the magnitude of the ice-field; whatever may have been the cause of the general wasting of the ice, its action was modified by a concurrent cause of a rhythmic nature, which alternately promoted and opposed the wasting. Under the joint action of the two causes the ice front first retreated with comparative rapidity, then halted, readvanced slowly over part of the abandoned territory, and finally halted a second time before beginning a second cycle; and each recessional moraine marks the position of the ice front at the close of such a cycle. This hypothesis, if well founded, is of far reaching importance. It affords a basis for the correlation of moraines in widely separated districts, and for the mapping of the ice sheet at various stages of its final waning. It affords a regularly graduated chronologic scheme of classification. It leads to an estimate of the duration of a definite portion of geologic time, far superior to any based on phenomena of erosion. And it probably assists in the discussion of the cause of the ice age.

When the hypothesis was first presented it was applied to the making of a time estimate. In the present paper it is applied to local geology, the correlation of moraines and associated phenomena in a district about Lakes Erie and Huron. After a general discussion of the function of the ice front as a dam to retain glacial lakes, and of the theoretic relations of successive positions of the dam to cols, and the resulting location of shore lines and channels of outlet, an account is given of the actual positions of the ice-dam within the district and of the resulting series of glacial lakes. A map of moraines includes not only data from various sources previously publisht, but important new material, especially for the Canadian peninsula, and is adjusted to the subject in hand by the indication of the theoretic continuations and connections of partly surveyed moraines. Other maps show the glacial lakes, outlined with detail and confidence not only on the land side, where their shores are still preserved as dry beaches and terraces, but also the ice side, where all actual vestige has necessarily disappeared.

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[1] Moraines of Recession and their Significance in Glacial Theory. JOUR. GEOL. Vol. V, 1897, pp. 421–465.

Lake Maumee, in the western part of the Erie basin, lasted during three oscillations of the ice front, growing larger with each shifting of the dam. At first its discharge was at Fort Wayne and thence down the Wabash River; afterwards part of its surplus escaped across the "thumb" of Michigan at Imlay, running westward to the Lake Michigan basin. In the later part of its life the broad upland of the peninsula of Canada was a nunatak. Lake Whittlesey, succeeding Lake Maumee in the same basin, held place for a single morainic cycle. The Canadian upland, no longer a nunatak, formed part of its northeastern shore, separating two ice lobes. Its discharge crost the thumb of Michigan at Ubly to a lower glacial lake, Saginaw, and thence ran westward through the Pewamo channel across the lower peninsula of Michigan. Lake Warren, uniting Lakes Whittlesey and Saginaw, at the level of the latter, endured for four morainic cycles, being greatly modified in outline by the successive changes of the retaining dam and becoming eventually much larger than its predecessors.

It is to be noted that the author did not delay the publication of his generalization until the ground had been wholly covered by observation nor until all the observations made use of had been verified. While guarding against misapprehension by constantly drawing the line between fact and theory, he has freely used his working hypothesis for purposes of local interpolation. To whatever extent his local generalizations are deductions from theory they will eventually, through the extension of observation be made to serve as tests of the theory.

Taylor dwells on the peculiar significance of the Ubly channel as an evidence of the existence of glacial lakes and a glacial dam, and closes with a general argument (drawn out by criticisms of J. W. Spencer) in support of the fundamental theory that the ice sheet served as a dam for the retention of lakes.

A corollary of some interest, not mentioned by the author, relates the history recorded by recessional moraines to that associated with Niagara gorge. From the beginning of the last ice retreat at Cincinnati Taylor counts seventeen moraines to Rochester, beyond which point new conditions enter, making the continuance of the analysis a matter of great difficulty. But just at the close of the term represented by these moraines the Niagara began its work, so that the moraine history is complemented by the river history. Together they represent all the time since the latest ice maximum, a period whose measurement in years is far more valuable to science than the determination of the age of the great cataract. Postulating the astronomic cycle of the precession of the equinoxes as the cause of the morainic cycle, the approximate time covered by the morainic history is computed (by the reviewer) at 315,000 years. This is so long a period in comparison with the most ample of modern estimates for the age of the Niagara that the uncertainty as to Niagara's age is of little moment in considering the sum of the two periods. Broadly stated, the hypothesis that the recessional moraines are functions of the precessional cycle estimates the time since the last maximum of glaciation at 300,000 to 400,000 years.

G. K. G.

The Influence of the Carbonic Acid in the Air upon the Temperature of the Ground. By PROFESSOR SVANTE ARRHENIUS. *Philosophical Magazine and Journal of Science*, Vol. XLI (Fifth Series) 1896, pp. 237–276. *La Revue Générale des Sciences*, Mai, 1899, pp. 1–22.

Professor Arrhenius was led to investigate this subject by the debates among the Swedish geologists upon the cause of the glacial and interglacial climates of the Pleistocene. The conclusion that none of the current hypotheses are satisfactory or at all competent to explain the observed phenomena led him to calculate the quantitative effect of any given variation in the amount of atmospheric carbon dioxide upon the temperature of the earth's surface. The fact that the carbon dioxide and water vapor are the chief agents in retaining the heat radiated from the earth's surface had long been known qualitatively and even the relative values of the selective absorption of radiant energy for the various atmospheric gases had been determined, but it remained for